Edison Storage Battery Company Records
Research Notebook (1901-1903)

This bound volume contains experimental notes and test results by Robert Rafn. The book covers the period March 1901-May 1903, but one of the loose items found in the book dates from 1900. The entries deal with a variety of competing storage batteries, including the Jungner battery; a motor and speed controller for electric vehicles; and an electric meter. A blueprint of a "Chloride Accumulator" has been pasted into the back flyleaf. The first page has been used as a table of contents. The cover is stamped "Record." The book contains 197 numbered pages; many pages are blank.

All entries in the book, including the blueprint, have been selected. Of the numerous loose pages, only the two dated items have been selected.

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First Discharge on Constant Current.

Constant Current. 20 Amperes.

No.	Time	Voltage. Closed	Voltage. Open.	Amp Hour.	Volt Amp	Volt Amp Hour.	Intern Drop	Efficiency	Resistance.
1.	3.20	2.00							
2.	3.45	1.975	2.03	8.33		24.89	.055	.9729	.00275
3.	4.15	1.96	2.02	18.33		19.67	.06	.971	.003
4.	4.46	1.93	2.01	28.33		19.45	.08	.961	.0045
5.	5.15	1.90	1.99	38.33		19.15	.09	.954	.00475
6.	5.45	1.865	1.97	48.33		18.82	.105	.947	.00525
7.	6.15	1.81	1.93	58.33		18.31	.12	.938	.006
8.	Out.								
8.	7.55		2.02						
9.	8.00	1.81	1.92	59.99			.11	.942	.0055
10.	8.15	1.69	1.82	64.99		8.79	.13	.929	.065
11.	8.20	1.00	1.80	66.65		2.137	.80	.556	.0444
						121.277			

Second Discharge on Constant Resistance.

No.	t	$\frac{4}{t}$	e	E	it	ei	eit	E÷e	$R=\frac{E-e}{i}$	E−e
1.	3.10	35.	1.95							
2.	3.15	34.4	1.95	2.05			5.64	.952	.002	.10
3.	3.30	34.2	1.93	2.05	11.47		22.28	.943	.0035	.12
4.	3.45	33.5	1.91	2.03	19.97		38.35	.942	.0035	.12
5.	4.15	32.6	1.84	1.95	36.67		69.95	.929	.0043	.14
6.	4.30	31.7	1.79	1.95	44.69		84.86	.917	.00505	.16
7.	4.45	30.0	1.69	1.89	52.40		98.98	.895	.00608	.20
8.	5.00	24.3	1.35	1.80	59.19		109.40	.751	.0188	.45
9.	[illegible]	[illegible]								
10.	[illegible]	[illegible]								
11.	[illegible]	[illegible]								
12.	[illegible]	[illegible]								
13.	[illegible]									

Third Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R.	E-e.
1.	11.00	49.0	1.95							
2.	11.05	46.5	1.94	2.09	6.366		12.316	.928	.00322	.15
3.	11.12	46.4	1.93	2.08	9.456		18.466	.927	.00324	.15
4.	11.15	46.3	1.925	2.07	11.773		23.031	.929	.00313	.145
5.	11.20	45.9	1.915	2.07	15.614		30.496	.925	.00335	.155
6.	11.25	45.6	1.905	2.05	19.426		37.886	.929	.00340	.155
7.	11.30	45.3	1.89	2.04	23.213		45.076	.926	.00331	.15
8.	11.35	44.8	1.87	2.03	26.967		52.136	.922	.00367	.16
9.	11.40	44.5	1.86	2.02	30.687		59.076	.921	.00360	.16
10.	11.45	43.2	1.85	2.01	34.382		65.936	.921	.00362	.16
11.	11.50	43.7	1.82	1.99	38.044		72.661	.914	.00379	.17
12.	11.55	43.0	1.805	2.00	41.650		79.211	.902	.00452	.195
13.	12.00	42.5	1.775	1.93	45.216		85.591	.929	.00365	.155
14.	12.05	41.5	1.73	1.84	48.716		91.721	.939	.00265	.11
15.	12.10	40.4	1.67	1.80	52.125		97.356	.927	.00324	.13

Fourth Discharge on Constant Resistance.

No.	t.	i.	e.	E.	it.	ei.	eit	e÷E	R.	E-e.
1.	8.50	66.	1.88	2.04				.922	.00272	.16
2.	8.52	68.6	1.89		2.24		4.2			
3.	8.55	67.	1.88	2.05	5.13		9.62	.917	.00284	.17
Changed Resistance Slightly							[illegible]			
4.	8.55	65.5	1.875							
5.	9.00	65.2	1.85	2.03	10.81		20.16	.913	.00295	.18
6.	9.05	67.0	1.82	2.04	16.45		30.51	.892	.00325	.22
7.	9.10	63.6	1.805	2.03	21.77		40.15	.889	.00354	.225
8.	9.15	62.3	1.79	2.01	27.015		49.47	.891	.00357	.22
9.	9.20	60.9	1.75	1.99	32.155		58.39	.879	.00395	.24
10.	9.25	60.0	1.72	1.98	37.555		66.94	.868	.00434	.26
11.	9.30	58.1	1.67	1.94	42.515		74.91	.862	.00464	.27
12.	9.35	53.4	1.54	1.85	47.075		81.35	.832	.00580	.31
13.	9.40	48.3	1.38	1.84	51.315		86.50	.751	.00954	.46
14.										

Fifth Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R.	E-e.
1.	1.20	37.0	1.95	2.08	[illegible]			.938	.00357	.13
2.	1.40	35.4		2.06	12.066		23.326			
3.	1.40	76.1	1.83							
4.	1.41	73.5	1.825		13.312		25.537			
5.	1.42	73.4	1.82		14.536		27.757			
6.	1.43	73.0	1.82		15.756		29.961			
7.	1.43	35.1	1.93	2.05				.942	.00399	.14
8.	1.48	35.1	1.926	2.05	18.681		35.661	.939	.00413	.145
9.	1.53	35.05	1.92	2.05	21.601		41.221	.936	.00428	.15
10.	1.58	34.95	1.91	2.04	24.516		46.801	.937	.00372	.13
11.	2.03	34.9	1.90	2.03	27.426		52.351	.936	.00373	.13
12.	2.03	73.5	1.78							
13.	2.04	72.0	1.77		28.638		54.505			
14.	2.05	71.1	1.76		29.830		56.655			
15.	2.06	70.6	1.75	2.02	31.018		58.740	.866	.00383	.27
16.	2.06	34.5	1.88	2.02				.932	.00406	.14
17.	2.11	34.4	1.875	2.01	33.893		64.140	.933	.00393	.135

Fifth Discharge. Concluded.

18.	2.16	34.1	1.87	2.02	36.753		69.500	.925	.00440	.15
19.	2.21	33.8	1.85	2.00	39.581		74.766	.925	.00444	.15
20.	2.26	33.7	1.84	1.99	42.391		79.940	.924	.00445	.15
21.	2.26	70.0	1.69							
22.	2.27	67.1	1.66		43.533		81.834			
23.	2.28	65.9	1.63		44.641		83.678			
24.	2.29	65.0	1.61	1.97	45.781		85.445	.817	.00554	.36
25.	2.29	32.7	1.78	1.96				.908	.00581	.18
26.	2.34	32.1	1.76	1.95	48.431		90.225	.903	.00592	.19
27.	2.39	31.7	1.73	1.93	51.091		94.865	.897	.00632	.20
28.	2.44	30.6	1.67	1.89	53.686		99.285	.884	.00718	.22
29.	2.49	29.0	1.58	1.87	56.171		103.635	.845	.00863	.25
30	2.49	55.0	—	1.81						

Variations in resistance are made to illustrate the increase of power used on hills.

Sixth Discharge on Constant Resistance.

No	t	i	e	E	it	ei	eit	e÷E	R.	E-e.
1.	1.10	38.5	1.96	2.06				.953	.00267	.10
2.	1.15	37.4	1.96	2.08	3.17		6.22	.943	.00321	.12
3.	1.25	37.2	1.935	2.07	9.986		18.13	.935	.00363	.135
4.	1.35	37.	1.92	2.06	17.169		30.05	.934	.00378	.14
5.	1.45	36.6	1.91	2.04	23.302		41.80	.936	.00355	.13
6.	1.55	36.3	1.89	2.03	29.377		53.34	.932	.00386	.14
7.	2.10	35.4	1.845	2.00	38.339		69.05	.942	.00438	.155
8.	2.20	34.5	1.78	1.96	44.164		79.59	.908	.00522	.18
9.	2.30	33.1	1.72	1.94	49.814		89.31	.887	.00665	.22
10.	2.45	29.5	1.26	1.80	57.024		100.73	.701	.02204	.54

Seventh Discharge on Constant Resistance.

No	t	i.	e.	E	it	ei	eit	e÷E	R.	E-e.
1.	9.40	36.	1.97							
2.	9.50	35.8	1.975	2.08	5.983		11.798	.950	.00293	.105
3.	10.05	35.5	1.955	2.06	14.895		29.278	.950	.00295	.105
4.	10.15	35.3	1.935	2.06	20.795		40.718	.939	.00354	.125
5.	10.45	34.1	1.88	2.00	35.145		73.818	.940	.00352	.12
6.	11.00	33.3	1.83	1.98	46.567		89.448	.924	.00437	.15
7.	11.30	28.1	1.54	1.88	61.917		114.878	.820	.0122	.34
8.	11.36	13.0	1.45	1.80	63.082		117.985	.806	.0269	.35

Eighth Discharge on Constant Resistance.

No	t	i	e	E	it	ei	eit	e÷E	R	E-e.
1	10.25	35.1	2.02	2.10	[illegible]			.972	.00237	.08
2	10.35	33.4	1.97	2.08	5.708		11.52	.948	.00329	.11
3	11.05	32.8	1.93	2.04	22.258		43.79	.947	.00335	.11
4	11.25	32.1	1.89	2.02	43.074		64.44	.943	.00405	.13
5	11.40	31.5	1.85	2.00	57.024		79.30	.925	.00476	.15
6	11.55	30.7	1.80	1.96	58.799		93.54	.918	.00522	.16
7	1.00	33.0	1.89	2.01				.940	.00374	.12
8	1.20	27.1	1.58	1.88	68.849		111.75	.841	.01106	.30
9	1.24	22.7	1.32	1.80	74.361		118.80	.733	.02114	.48

Ninth Discharge on Constant Resistance.

No	t	i	e	E	it	ei	eit	e÷E	R	E-e.
1.	7.55	34.0	1.96							
2.	8.00	33.3	1.97	2.08	2.812		5.515	.948	.003303	.11
3.	8.15	33.2	1.95	2.07	11.124		21.815	.942	.00398	.12
4.	8.30	32.8	1.93	2.06	19.374		37.815	.937	.00426	.13
5.	8.45	32.4	1.90	2.04	27.524		53.335	.932	.00454	.14
6.	9.00	31.9	1.87	2.00	35.561		68.365	.934	.00407	.13
7.	9.15	31.2	1.82	1.98	43.448		82.885	.919	.00512	.16
8.	9.30	28.9	1.69	1.92	50.710		95.610	.881	.00797	.23
9.	9.40	23.7	1.37	1.80	55.093		102.316	.762	.01814	.43

Tenth Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R	E-e
1.	8.40	34.8	1.98	2.06				.961	.00229	.08
2.	8.55	33.3	1.96	2.08	8.512	14	14.768	.942	.00360	.12
3.	9.10	32.9	1.93	2.05	16.787		30.862	.942	.00365	.12
4.	9.30	32.3	1.89	2.03	27.663		51.616	.932	.00433	.14
5.	9.45	31.7	1.85	2.00	35.663		65.576	.925	.00473	.15
6.	10.00	30.4	1.78	1.96	48.440		79.709	.908	.00592	.18
7.	10.15	27.3	1.60	1.90	50.652		91.727	.892	.01098	.30
8.	10.24	22.7	1.35	1.80	64.518		97.871	.751	.01982	.45

Eleventh Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R	E-e
1.	8.15	34.0	1.97	2.08				.948	.003235	.11
2.	8.32	33.0	1.95	2.06	9.486		18.582	.947	.003333	.11
3.	8.47	32.7	1.94	2.05	17.698		34.564	.937	.003975	.13
4.	9.02	32.0	1.895	2.04	25.785		50.070	.929	.004531	.145
5.	9.17	30.9	1.82	2.00	33.647		64.669	.911	.005525	.18
6	9.26	26.0	1.47	1.80 ?	37.913		71.686 ?	.817	.012692	.33

Twelveth Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R	E-e
1.	3.35	35.5	2.02	2.23				.905	.00591	.21
2.	3.45	33.6	1.98	2.08	5.741		11.482	.952	.00297	.10
3.	4.00	33.0	1.96	2.07	14.066		27.882	.947	.00333	.11
4.	4.15	32.6	1.93	2.06	22.266		43.831	.937	.00368	.13
5.	4.50	31.	1.82	1.98	40.816		78.612	.920	.00576	.16
6.	5.05	29.9	1.75	1.95	48.303		91.976	.898	.00679	.20
7.	5.20	26.0	1.54	1.86	55.265		103.150	.828	.0123	.32
8.	5.22	24.6	1.46	1.80	56.108		104.414	.817	.0139	.34

Thirteenth Discharge on Constant Resistance.

No.	t	i	e	E	it	ei	eit	e÷E	R	E-e
1.	1.25	34.5	2.01	2.21				.909	.00579	.20
2.	1.35	33.3	1.97	2.08	5.65		11.243	.953	.00333	.11
3.	2.08	32.5	1.93	2.06	23.745		46.428	.937	.00400	.13
4.	2.20	32.0	1.90	2.03	30.195		58.779	.936	.00406	.13
5.	2.50	31.0	1.81	1.96	45.945		87.994	.923	.00486	.15
6.	3.15	22.0	1.28 ?	1.80 ?	57.985		106.595	.712	.02545	.56
7.										
8.										

Aug. 1901.

Experiments on ~~an~~ Zinc-amine-Nickel Battery.

Essential for the operation of such cell as an accumulator are the following three conditions.
1) That the amine in question is a conductor
2) That it does not dissolve, during electrolysis in either direction Zn(OH)$_2$ and any Nickel hydrate.

3) That electrolysis between inactive poles does not change the chemical constitution of the said amine (– or – that if a change takes place, this process is reversible)

The behaviour of the electrolyte in regard to 1 is shown in col 3 & 4.
The voltages given are combinations of a) voltage of decomposition of the Amin. b) gas polarisation and c) Resistance Exp.

The test regarding 2) is effected by incorporating a fulled sh., that has been for some time in contact w. freshly ppt Zn(OH)$_2$ and nothing Residue. Test Ectum.
3) is partially answered in 5, 6, 7.
5 and 6 giving estimated percentage of theoretical amount of gas, evolved at the poles.

No	Name & Formula.	Preliminary Conductivity Test. Milliamp.	Voltage.	Amount of gas set free on pots. Anode	Cathode.	Remarks on appearance of Platin. pots.	Relative Cost.	Remarks.
1.	Aethylenediamine.	17.%	7.V.	0	100%	Yellow coating on anode.		Residue on evaporation
2.	Hexmethylene amine.	17	9	10%	100%	Bubbles normal.		Slight residue
3.	Diethylamin	17	8	10%	100%	" "		Residue
4)	Disobutylamin	17	7	0	100%	" "		Residue
5	Trioxy aethylene diamin.	17	4½	(nearly) 100%	100%	" "		Dissolves Zn(OH)₂ readily
6	Cyandiamin.	17	4	nearly 100%	100%	" "		Slight residue

No	Name & Formula	Preliminary Conductivity Test Amps	Volt.	Amount of Gas set free on pole, cubic. Anode	Cathode	Remarks on Appearance of Electrodes etc.	Relative Cost	Remarks.
7	Triaethylamin.	17	6	0	100%	Normal.		No Residue. i.e. Zn(OH)₂ insoluble.
8	Tetra aethyl ammon. Hydroxide							No Residue
9	Tetra methyl Ammon Hydrox.	17	4.	70%	100%	Normal.		No Residue
10	Tri Triaethylamin.	17	4½	40%	100%	Dark brown deposit on + pole.		No Residue
11.	Tetra aethyl - Oxymethylamine.	17	4½	30%	100%	Normal		No Residue
12	Tetra methyl Oxymethylen amin.	17	4½	20%	100%	Normal		No Residue
13.	Tetra aethyl Ammon Hydroxide.	17	3	10%	0%	Strong deposit on + pole.		No Residue

No	Name of Formula.	Preliminary Conductivity Test Milliamp	Volts.	Amount of Gas set free on poles Anode	Cathode	Remarks on Appearance of Platinum poles &c.	Platinum Coat.	Remarks.
14.	Diallylamine.	17	6	10%	100%	+ pole blackened and O given off in big gas bubbles.		Residue.
15	Triethylamine	17	4	10%	100%	Strong deposit on + pole.		Slight Residue
16.	Benzylamine.	17	9	5%	100%	Normal.		No Residue
17.	Propylamine.	17½	6	0	100%	"		Residue.
18	Triallylamine.	17	4		100%	Oxygen pole blackened — large O bubbles.		
19.	20% KOH.	18	3.25	100	100	Normal.		Dissolves completely.
20.	Amylamine.							

Dec 16 1902.

The result of the above described experiments was the following. None of the 20 amines is stable enough to resist electrolytic oxidation, which is of course the essential feature of an electrolyte of this class. For the case that these electrolytes are to be used in connection with Zn & Ni electrodes, it is also required that the Zn oxide formed is reducible to metallic Zn in presence of the electrolyte. To test this latter property, two little grids, one of Mg containing a mixture of finely divided metallic Mg and freshly prept. $Zn(OH)_2$ or sublimed Zn, and one of sheet nickel containing $Ni(OH)_2$ & graphite, were used as electrodes. The Zn oxides were in no case reducible to any perceptible degree.

No 12: Tetramethyl oxymethylene amin is subjected to electrolysis between two platinum wires in small test tube.

Sept 14, noon
Current ~~4½ Volts~~ 21 m/l gives a voltage on the terminals 4¼ Volts.
while 20% KOH shows, under same conditions 18 m/l 3¼ V.

At the start of the experiment about 20% of the total amount of O is set free on the anode, this most possibly decreasing the voltage at the terminals in correspondence with the heat of formation of the oxyde. Hypothetical in the electrolyte.
As the experiment goes on the amount of O evolved seems to increase
On Monday after 19-20 hours run the full amount of O is evolved and the readings are: 14.5 m/l. 4.8 V.
By this time the solution must have reached the highest state of oxidation (CHO to $C_6H_{12}O_7$)

For the positive platin wires we substituted a Nickel grid and a Zn grid, both having Zn(OH)₂ freshly prep. on a Mg grid. The oxygen compounds on the anode i.e. some and dissolve the metallic hydrate, the solution leaves out of the pores of the grid, and the metal hydrate is again prepared, out of sol. by the still unoxidized electrolyte.

Nov & Dec 1902.

Experiments in Dome Patents
U.S.P. 389882, Sept 25 '88.

Examples on Batteries, having unchangeable Electrolyte:

Zn :	Phosphate of Potash or Soda	Cu :	Phosphate
	Borate " " "		Borate
	Silicate " " "		Silicate

Active masses to be pressed into self-supporting cakes or to be packed around cores or sheets of either metal, and wrapped in sheet asbestos, prepared according to patent of Jan 26 1888.

Dec 16. '02.

Sheets of the following metals:

Cu
Fe
Ni
Pt
Ag

Size 1" × 1½. put as Anodes in pyrant KOH 20%, and run at .2 amp. The Kathode are pieces ¼ × ¾ of sheet platinum.

After 24 hours run at the density of .067 amp per sq inch. the deposits on the kathodes are dissolved of in dilute HNO_3 (In case of Iron Anode, in HCl) and KOH is added till ppt. is formed. (In case of Ag. HCl is used)

Ppt washed on filter & ignited.

2 mg. deducted for weight of ashes.

From Cu - - -
" Fe 10.5 mg 7.5 mg net Iron
From Ni & Pt - Big comp w Pt, estimated to 5 mg.
" Pt 3 mg. appears to be all Iron
" Ag 16.5 mg. 12.5 mg net Ag

After 10 days. Copper eaten into two pieces. below kathode shows a big bunch of spongy blue. Iron Kathode as well as anode coated with black solution purple and lower at bottom of glass, estimated to .3 cm.

Nickel Kathode and anode as well as Pt kathode & anode perfectly bright, and no precipitate.

Jan 13th 1903.

Preliminary experiments on mercury contacts for Wimpler machines.

Copper and silver amalgamate too easily to be employed for contact surfaces for these experiments. Nickel and Iron amalgams unexpectedly to readily to be run in open atmosphere, in which case I may have to enclose contacts in H_2 or N_2.

A piece of sheet nickel weighing 2.665 g, and a piece of sheet iron of about the same surface, and weighing 2.439 g, are cleaned, amalgamated w. sodium amalgam and put into mercury on Jan 7. by morning.

Jan 7. 30 mg of the sample of graphite, submitted by Jungner, and stated to be of the graphite employed by him in his accumulators of 1901 — and 30 mg of the Edison graphite, put into glass rings of 20 mm diameter on microscope slides. The flaked E-graphite shows a superior power of covering, on rough estimate 6-7 times the covering power of the Jungner graphite.

Jan 9 Mechanically all right. keeps mercury. Wheel and ring run equally, nickel plated but the coating had to be satisfied to get surfaces true

9 —— All contact parts of iron. This arrangement will allow measuring of

of resistance as well

Copper amalgamates readily and is in course of days consumed in Hg. Sample of

Jan 10 A small sheet of iron, same size as those used in experiments of Jan 7 amalgamated w. Sodium amalgam and washed in Mercury. Weight before treatment 3750 mg. The mercury is suspended off in a reducing flame. Weight after treatment: 3745. Hence loss of weight by regular amalgamation 5 mg.

10 Piece of sheet iron: 3880 mg and piece of sheet nickel 3850 mg amalgamated by means of sodium amalgam and washed in mercury. Put in steam plates and corked. Temp. about 80°C.

14 after looking at that temp for 4 days pieces tested to drive of the Hg.
Weight of the iron 3675 mg.
" " nickel 3850

15. Nickel from Nickel Sulphate, polished, into mercury. in order to try oxidizing properties of di-amalgam.

I have found that iron and nickel surfaces carefully cleaned and amalgamated by Sodium amalgam & drops of dilute acids, and again well washed - very soon - say after few minutes - turn dull and

and lose the property of coalescing with mercury. This may be due to oxydation or to saturation of the mercury, or both. It cannot well be due to saturation of the mercury with metal, as this would necessitate a steady consumption of the metal since excess of Hg is present - which does not exist, as shown by preceding experiments. Thus this point must be due to an oxidation only, the metals, Fe & Ni, being in an easily alkaline state in the amalgam.

A piece of sheet nickel, treated as stated above, and kept in a sealed bottle, partly filled with perpropylbetaine of Potash in 20% KOH, remains bright and mercury-like for months.

In a unipolar dynamo, then, the contact surface, if once well amalgamated, may be kept bright for any length of time provided that the machine can be so constructed that these surfaces are working in H, N, and likely, CO_2 and CO.

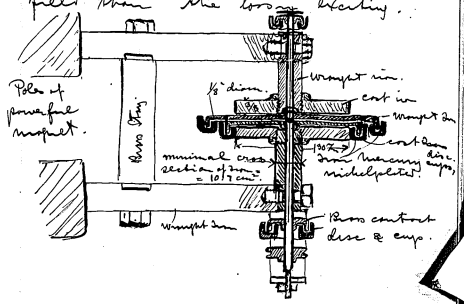
Owing to very poor facilities in the time of the preliminary experiments, I never was able to get any reliable data on the resistance of a moving mercury contact. It should be a function of mechanical precision only. When Hg is kept clean and pure one time, the mechanical

resistance, as shown by armature was very slight.

April 2. The unipolar was taken up several times with long intermission. The encouraging idea was the following. The conductor is moved in a strong field; when current is taken out there is of course a mechanical reading force of corresponding order, and if field is left free to rotate it does so – nearly synchronously with the armature. If the field is fixed, however, does there not then exist a tendency to rotate the magnetism of the field? and at such rate, that the work betrayed in the armature + the external work of the armature current equals the work betrayed by eddy-currents in the field? I have all the things here among, that so may not be the case, and that I may look upon lines of force as to concrete; for a rotation as mentioned should produce no change of magnetic potential, anywhere in the field.

If on the other hand such rotation and such loss of energy really takes place, and if this loss is what certain authors let pass under the name of armature reaction, then I have a good due. By arranging two concentric (or in case of discs parallel) armatures, and turning them at the same speed in opposite direction, ~~so that the current cons~~

reading them in series. This reactive retarding force is moreover, and there is no other loss in the field than the loss in exciting.



The experimental unipolar dynamo was built as shown – sketch. Owing to the small dimensions of the discs, these were warped and unfitted when relieved from the chuck of the lathe, and I was unable to straighten them. Thus the most important defect of the machine consisted in the excentricity of the contact edge of the discs and the reading brushes out of the measuring at speeds exceeding 800 per min. or even less.

Assuming a density of 16000 lines of force per cm² in the minimum section of the wrought iron circuit, the mean induction in the airspace and armature will be:

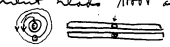
$\frac{10.7 \cdot 16000}{\frac{\pi \cdot 12}{4}} = 1300.$ rubbed in a good

desired less than desireable for expts within wide range. It is the old experience: we want to use old pieces and build cheap for fear the accounts! to high, and the result is deficient apparatus & incomplete expts.

Running as a motor, the armature accelerates till they reached speed too high, for the mercury contacts, rubbing out the Hg and breaking the contacts. The current was on the magnetizing of 120 ℓ. At an air induction of some 8000 lines, the efficiency might have been within reasonable limits; at the above stated induction, the force was very slight.

The following expts disproved my theory

1) Magnet not excited, armature a carrying 60-80 amps and rotated about 500 rev, showed no trace of potential at terminals of stationary armature b. (Instrument reads 1/1000 V and shows 1/10000)



Hence the mutual induction is negligible.

2) Magnet excited, other conditions as 1). no voltage in the stationary armature b and some tendency of same to rotate. 150 amps in armature a show no effect in b.

Conditions were varied and expts repeated numerous times with same results; it may therefore be considered established that no rotation of the field magnetism takes place. (Pathological mistake!!)

Experiments on concentration changes and concentration capacities of the Edison Electrodes.

May 9 '03. Weight of Ni-Electrode w. in broad single jar, 14.25 g. (Thoroughly dried after soaking in pure water, under 27" vacuum for ½ h., surface wiped off w. filter-paper: weight 14.69 g. Increase due to absorbed water: .44 g.
Weight of active mass.
Approximate volume of inclosed, pressed briquette:
Porosity: %.

Edison Electric

Integrating Meter. Lab-no 868.

1) Test of Norway Iron core, well annealed, — 0 7/8" long. 1 5/16" external diameter 1/16" walls.

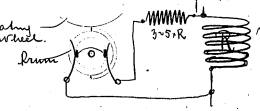
1.	4.50 Amp.	1210 Deflection	26.	3.085 Amp.	951. Deflection
2.	4.25	1185	27	3.00	935
3.	4.00	1045	28	2.90	912
4.	3.75	1104	29	2.75	887
5	3.50	1050	30	2.60	841
6	3.25	1000	31	2.50	816
7	3.00	944	32	2.07	658
8	2.75	883	33	1.78	572
9	2.50	815	34	1.53	485
10	2.77	875	35	1.33	405
11	2.90	905	36	.93	250.5
12	3.00	920	37	.72	177.0
13	3.25	980	38	.50	113.0
14	3.12	967	39	.37	69.5
15	3.00	937	40	.24	56
16	2.90	912	41	.16	45.5
17	2.75	882	42	.0914	37.
18	2.65	855	43	.068	35
19	2.49	815	44	.058	35.2
20	2.67	850	45	.046	33.
21	2.765	871	46	0	31
22	2.91	904	47	.046	33
23	3.00	925	48	.0792	34
24.	3.11	948	49	.100	35
25	3.26	980	50.	.210	45

over.

Continued

No 51	.400	Amps	77.0	Deflection	75	2.75	Amps	856	Deflection
52	.50	"	98	"	76	2.88	"	887	"
53	.61	"	125	"	77	3.00	"	914	"
54	.79	"	199	"	78	3.14	"	946	"
55	1.15	"	305	"	79	3.255	"	9055	"
56	1.50	"	436	"	80	3.12	"	948	"
57	1.80	"	546	"	81	2.98	"	920	"
58	2.065	"	640	"	82	2.84	"	889	"
59	2.45	"	767	"	83	2.75	"	869	"
60	2.50	"	779	"	84	2.62	"	835	"
61	2.67	"	826	"	85	2.57	"	809	"
62	2.77	"	854	"	86	2.63	"	830	"
63	2.76	"	900	"	87	2.75	"	860	"
64	3.05	"	910	"	88	2.88	"	890	"
65	3.16	"	949	"	89	3.00	"	914	"
66	3.30	"	979	"	90	3.14	"	945	"
67	3.12	"	949	"	91	3.25	"	971	"
68	3.00	"	9235	"	92	3.41	"	1020	"
69	2.86	"	895	"	93	3.48	"	1017	"
70	2.75	"	870	"	94	3.62	"	1040	"
71	2.62	"	836	"	95	2.83	"	1150	"
72	2.50	"	8045	"	96	4.20	"	1155	"
73	2.52	"	805	"	97	4.55	"	torch	"
74	2.63	"	830	"	98	—			

The curve shows that the difference between the readings on upgoing and downgoing curves can be reduced to ca 30% of the original by shunting 1/3 of the current through a resistance parallel to the main coil — once for each revolution of the drum.



The drum would in this case have to be corrugated, so as to prevent the integrating wheel from sliding when the short-circuiting takes place. This would be at the instant, when the integ. wheel enters the straight edge of the elevated part of the drum.

Supposed that the meter is adjusted for the mean curve of deflection, and the lights in the house are lit and turned out as follows:

1 Hall light turned on at	4.00 pm	1 light	
3 Kitchen lights at	5.00	4 "	
5 Parlour " "	5.00	9 "	
5 Dining room " "	6.00	14 "	
" " turned out	8.00	9	
3 Kitchen " " "	9.00	6	
6 Bedroom " " on	11.00	12	
5 Parlour " " out	11.00	7	
All out	12.00	0	
Total		66 Light hours	

The meter is built for 25 lights.

According to the curve, the meter would indicate:

1 Hour	at	.875 Light	=	.875
1 "	"	8.725 "	=	8.725
2 "	"	13.600 "	=	27.200
1 "	"	9.200 "	=	9.200
2 "	"	6.250 "	=	12.500
1 "	"	7.250 "	=	7.250
Total				65.750 Light hours

The meter would consequently charge for 99.55 % of what was used.

Example of a most unfavorable case:

2 hall lights on at	4.00 (2) =	2	Light Hours
3 Kitchen " "	5.(5) =	5	" "
6 Parlour " "	5.(11) =	6	" "
6 Living room "	6.(17)	68	" "
6 Bedroom lights at	10.(23)	46	" "
All out at	12 o'clock (0)	127	" "

The meter integrates:

1 Hour at	1.870	=	1.870 Light Hours
1 " "	10.625	=	10.625
4 " "	16.500	=	66.000
2 " "	22.675	=	45.350
Total			123.845 or 97.45%

This means a loss of 2.55%.

The maximal consume of energie in Motor is 2.5 Watt.
This corresponds to a current (at 110V.)
$i_{max} = \frac{2.5}{110} = .0227$ Amp.

Data of Meter „Model N" Nr 1200

Motor armature, two field coils and starting coil all in series.
Resistance of starting coil: 2790 ohm
field coils 6291 "
Armature 459 "
9540 "

Current at 110V: .01162 Amp.

Test of Electrolytic Iron-core.

A sheet-copper-tube of 1 3/16" diam and 6 7/8" length is given a coating of 1/32" to 3/64" of iron, plated out of double chloride of iron and ammonia.

The complete core is very much heavier than the Norway-iron one and can consequently not be compared with it, except as far as "percential" Hysteresis" concerned.
The thickness of the coating excessive for this started to crack in all directions - probably on account of change of temperature and difference in coefficients of expansion of the two materials. These cracks increase the magnetic resist.

1	5.43 Amps	1210 Deflection	26.	.075 Amps	111 Deflection
2	5.00	1197	27.	.105	126
3	4.69	1196	28.	.145	142
4	4.48	1170	29.	.180	156
5	4.05	1145	30.	.25	185
6	3.95	1132	31.	.385	237
7	3.90	1129	32	.50	283
8	3.12	1043	33	.67	343
9	2.31	959	34	.78	380
10	2.00	836	35	.95	430
11	1.59	723	36	1.05	458
12	1.32	638	37	1.38	546
13	1.32	637	38.	1.50	571
14	1.025	525	39.	1.78	630
15	.94	458	40	2.18	700
16	.69	396	41	2.27	730
17	.585	350	42	2.49	776
18	.44	285	43	3.22	900
19	.335	243	44	3.80	960
20	.25	198	45	4.00	1011
21	.173	.61	46	4.34	1061
22	.115	131	47	4.70	1109
23	.03	120	48	5.00	1140
24	.072	111	49	5.41	1176
25	.0—	79	50	5.88	1206

Se curve:

The Hysteresis is about 6 times higher than in the Norway core.

— What is the advantage of a hollow tube over a bundle of wire of same weight and same material?

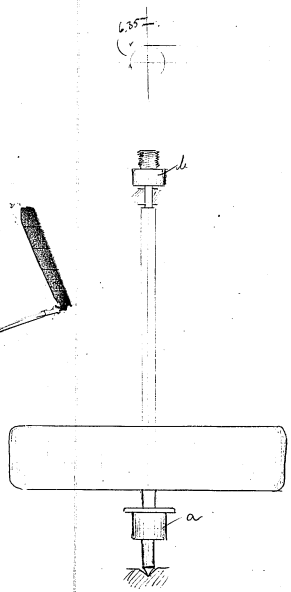
Electroplate tube, well annealed.

1.	6.85 Amps	1210 Deflection			
2.	6.23	1188	23	.075	87
3.	5.72	1143	24	.160	103
4.	4.98	1083	25	.270	183
5.	4.67	1060	26	.320	161
6.	4.26	1010	27	.530	200
7	3.97	950	28	.645	220
8	3.10	887	29	.720	254
9	2.69	774	30	1.00	297
10	2.29	654	31	1.26	355
11	1.88	509	32	1.53	411
12	1.57	575	33	1.87	483
13	1.86	445	34	2.46	603
14	.998	360	35	2.87	667
15	.79	309	36	3.09	707
16	.645	259	37	3.86	830
17	.536	222	38	4.81	893
18	.390	180	39	4.64	940
19	.270	140	40	4.95	976
20	.150	104	41	5.76	1057
21	.075	082	42	.036	1116
22	0	086	43	.072	1176

Se Curve

This curve is lower than last

Force required to move
Weber motor of 3 7/8" diam. (98.5 mm)



a) The force attacks on 6.35 in lever.
Brushes off.
7 g suffices to start and bring the motor up to regulating speed.
This corresponds to a force 1.82 g on the periphery of the armature.

b) The force attacks on the little cylinder b. i.e. 8.75 mm lever.
1) Brushes off.
5.3 g is sufficient.
This point of attack is near to the long bearing on top whereby the bearing friction is slightly increased.
7 g on 6.35 in lever corresponds to 5.32 g on 8.75 mm lever.
The increase of resistance is 8.4%
2) Brushes on.
Motor starts 9.2 g
After subtraction of 8.4% for friction:
3.4 g on 8.75 mm.
Reduced to the circumference: 1.5 g

c) Thread is attached to a point of the armature, 1 5/8" from centre: (41.3 mm)
Motor started by 1.7 g
Reduced to circumference: 1.4.5 g

The friction in the pulley is found to be: 1.5%.
Corrected results:
b2: 1.4.75 g } on 49.25 in lever.
c: 1.45 g }

The Motor resistance was in calculation. Hence the Energy required.

$$\frac{4925 \times 1.47 \times 2 \times \pi}{1000 \times 1000 \times 60} = \frac{76.8}{1000000} \text{ Watts}$$

or 7.5×10^{-7} Watt.

Approximate test of Regulation

Time required for 20 Revolutions at following Torques.

7 g on 0.35 in	36 1/2 sec
11 " " "	35 3/4
21 " " "	34 1/2

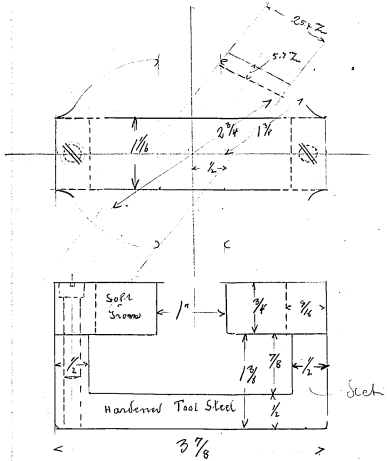
Determination of Induction in new permanent magnetic Field. (See Sketch)

As anchor is used a piece of soft Iron 1" by 1/2" by 6 3/8", placed. Surface of contact between Field and Anchor: $5.7 \times 25.4\ \text{mm}^2 = 145\ \text{mm}^2 = 1.45\ \text{cm}^2$

The lifting Power is measured at immediate contact and when layers of different Thickness separate Poles and Polepiece.

Magnet was originally magnetized by 7050 Amp. Turns.

The lifting power must have decreased to about 1/8 & 1/10 of Saturation.



0"	Lifting power at immediate contact:	1850 g
.00225"	" when .00225 paper on one pole.	1098 "
.0045"	" " " " each "	897 "
.00675"	" .0225" and .0045"	097 "
.012"	" .006 " .006	382 "
.022"	" .011 " .011"	105 "

The corresp. Inductions in the surface of contact is calculated as follows.

P = Lifting Power | F = Surface of Contact
B = Induction $\frac{\text{lines}}{\text{cm}^2}$ | = 1.45 cm²

$$P = \frac{B^2 \times F}{8 \times \pi} \qquad B = \sqrt{\frac{P \times 8 \times \pi}{F}}$$

Induction in Hardened Horseshoe

$$= B \times \frac{1.45}{3.48}$$

	Airspace	P	B	Magnetic Motive Force in Airspace
1	0	1850	5750	0 (×2.54)
2	.00285"	1100	4400	9.9 "
3	.00450	900	4050	18.0 "
4	.00675	700	3500	23.8 "
5	.0120	382	2600	31.0 "
6	.0240	105	1360	32.6
	New Series:			
7	.012 in	440	2800	53.6
8	.024 "	180	1800	43.2
9	.036 "	100	1330	48
10	.048"	70	1110	53.2
11	.020	200	1900	38
12	.065	88	1250	57.5
13	.088	63	1050	92.5
14	.153	32.6	760	116

The last 3 Values are more exactly determined. The calculation however does not hold good as the section of the Airspace is indefinite on account of leakage or spreading.

Supposing now, that in Expo 3. 90% of the Magnetomotive Force is destroyed in the airspace, the total MMF must be:

$(43.2 \times 2.54) \frac{10}{9} = 120.$

In Expo 1 these 120 are all used to conquer the Resistance in the steel and iron – of which that of the steel must be at least 80%.

The Induction in this case: 5750 is undoubtedly in the straightest part of the curve, so that below that point the magnetic Resistance may be considered constant.

The Permeability is $\frac{5750}{120} = 48$.

In case of the new Passinotti Armature is used, the area of the airspace is approximately $[(\pi \cdot 2.75 \times) - 2] \times 0.5 \cdot 0.75 \times 0.6745 = 8$ cm²

Section of Steel: $1\frac{1}{16} \times \frac{7}{16} \times 6.45 = 3.5$ cm²

The airspace is chosen: $\frac{17}{1000}$" on each side, in all 0.05 Z = 0.05 cm.

$$MMF = 120 = \left(.05B + \frac{8}{3.5} \cdot \frac{B}{48}\right) = B(0.05 + 0.0453) = 0.0953.$$

$$B = \frac{120}{.1095} = 1230.$$

B in Steel: $1230 + \frac{8}{3.5} = 2800.$

Average induction in the Airspace is

$\frac{1230}{2} = 615.$

Required number of Windings is then if .0227 is the maximum current and the Force required on 35 Z lever 2.2 g.

$$2240 = .0139 \times 615 \times n \frac{.66}{8.6}.$$

$$n = \frac{2240 \times 8.6}{.66 \times .0139 \times 615} = 342.$$

Or, as the Armature has 24 Slots

$n = 360 = 15 \times 24.$

Wire no. 30 (B&S) has 2450 feet to 1 lb when double cotton covered.

#30 has 7000' to 1 lb.

The Prices per lb.

#20	#30
$ 207	$ 4.93
$ .0845	$ .0705

, and perfectly

#36 wire carrying .025 Amp corresp to 2 Amp per in^2 – which is perfectly safe.

One turn will be about 2.5" long

300 turns 700 inches = 75 feet costing 5.3 cts.

One slot will be able to hold ca. 250 windings – the whole armature 6000 or 125.000 with 5200 slots.

Resistance this will cost ca $.80.

According to calculation the current would be .0013 Amp. and the energy

W = .143 Watt

Will start in with ca 3000 Winding and increase by steps – using current needed in each case.

—

March 6th '07.

It was found that on reason of the various airgaps the armature could not move smoothly, the magnetic "sticking" caused a very large loss of energy, which could only be diminished by increase of airgap.

The magnetic flow in motor has evidently been estimated too high – most probably on reason of poor contact between magnet and polepiece in lifting exp. (which causes higher estimation due smaller surface and thus gives wrong results for B ~~from~~ in $P = \frac{B^2 S}{8\pi}$.)

The armature was first wound with 24+100 windings and required about 30/1000 Amp at a speed of 120 rev per min. The new winding has 24+200 turns requiring .17/100 Amp at 125 rev.

In neither case the armature runs perfectly free and smooth – evidently poor mechanical finish.

In Practice the field magnet would be cast in one piece and consequently give a much higher MMF.

Test of different shaped iron cores

I Old Steel

Mill amp.	Deflection
4290	1200
3700	1077
3140	963
2590	760
2030	650
1660	529
1260	400
920	293
580	220
470	165
250	130
100	116
0	111
100	116
250	125
510	160
820	230
1120	318
1580	454
1790	555
2110	673
3540	925
3830	1057
4100	1157
0	110

II

Amps	Defl.
0	110
4850	1175
4150	1059
3660	959
3091	824
2590	681
1906	495
1438	350
990	232
740	180
490	144
250	120
100	110
0	109
100	111
250	116
550	147
770	184
1430	335
1990	570
2880	769
3600	934
4040	1027
4700	1163
0	109

Both cores have about same Weight. The difference between the curves must be due to the difference in "air gap" and magnetic saturation where the lines of force pass from iron to air.

III Core II cut to 5" length and lowered 1 9/16"

Mill Amp	Deflect.
0	110
3880	1233
3170	1050
2370	758
2150	570
1520	343
980	200
750	155
480	131
280	117
0	111

Mill amps	Defl.
230	117
480	131
760	158
1030	196
1580	347
2150	525
2980	1010
3520	1185

Poor start on reason of long path through top of Solenoide. Rapid increase on reason of higher sensitiveness caused by decrease of weight.

IV Same, lowered 5/8" (11/16 higher than in III)

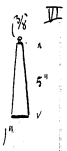
V " " 15/16 9/16 " " " III)

IV Mill	Defl.
4850	1050
3590	986
3020	840
2320	650
1860	586
1450	382
1000	239
600	160
250	124
0	113

V Mill	Defl.
4910	1262
4220	1161
3740	1085
3120	920
2350	661
2000	522
1410	284
980	165
250	85
0	55

Both show rather poor start.

VI



Tapered core, highest possible position

MA.	Defl.
0	55
4500	1112
3900	1055
3400	895
2850	752
2140	526
1780	398
1380	279
970	178
730	135
480	93
250	76
0	65

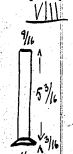
Start too weak and last part of curve too rounded on account of short core.

VII ½" cut off top and replaced by 1 3/16" of core II. Highest position.

MA	Deflection
0	50
4580	1140
4000	1082
3460	879
2930	780
2250	550
1750	405
1460	289
1000	190
500	94
250	69
0	54.

VII is considerably better. Would possibly by obtain same results if core was below – supposing only half the weight.

VIII



A broad collar as shown in fig does not require a deeper solenoid and increases at the same time the circumference of the lower part of core, thus diminishing magnetic resistance and making same less dependent on length of free core below solenoid.

VIII

Milliamp	Deflection.
0	50
4000	1165
3500	1000
2980	908
2260	671
1780	471
1370	340
1000	215
500	101
250	85
0	58.

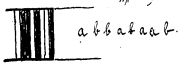
Beam made more sensitive in this exp. Considerably better curve.

The Solenoid used in all these exp. has for each side of 3 wire system 4 x 30 turns of no 16 wire. Arranged thus:

Length 3 1/8"

(This depends on a misunderstanding of the two papers. The coil has twice the amount arranged in 8 layers)

New Solenoid: 4 x 15 turns for each side, length 1 7/16"



The core VIII gives a very poor start in this solenoid. The evolution of the core goes on as follows:

Core VIII broad all through to half its diam: Beam hardly deflected at .5 Amp. In cases like this no complete test is made.

Continued 151

I. H.P. Automobile Motor.

Columbia Runabout Motor, originally wound for 30 V. Rewound in Italy for 40 V.

The Armature has 51 Slots each containing 8 Wires belonging to two windings of 4 turns in series.

When rewound each winding has in parallel two circuits of 2 turns of same size wire (# 11)

Resistance of rewound armature:

$$\frac{.28\,V}{9.6\,A} = .0292 \text{ Ohm}.$$

Including Brushes:

$$\frac{2.03\,V}{172\,A} = .1180 \text{ Ohm} \quad \frac{1.58}{10.6} = .149 \text{ Ohm}.$$

The Field winding (# 7) earlier having 4 coils in series, now arranged in groups of two has a resistance:

$$\frac{.75}{22.4} = .0335 \; ; \; \frac{.57}{16.4} = .034 \text{ Ohm}$$

For the following breaking exps. the motor is connected to one of the old sets of Accumulators.

On reason of high internal drop of Voltage in these the motor does not get the proper voltage and consequently shows a rather low efficiency.

Diam of Pulley 6 7/8". Arm of Brake 28".

	Voltage	Current	Speed	Weight	Watts Input	Watts Output	Efficiency	Remarks
1.	27 V.	74 A.	550	5 lbs.	1990 W.	1.14 HP	.44 %	
2.	33.5 "	63 "	900	45 "	2111 "	1.83 "	.645 %	
3.	32 "	60 "	944	(47 lbs.)	1920 "	[illegible] "	[illegible] %	2 Lines of 2 Pairs of Bolts in Parallel
4.	30 "	98 "	397 "	[illegible]	2940 "	[illegible] "	[illegible] %	

The corresponding drops of Voltage in Number of Amperes near 17 A

(1) 13.3 V. ; (2) 11.35 (3) 10.8 (4) 17 Volts

This shows, that drops in battery is low.

The brake gives no very exact results, and Tachometer is applied and speed is unreliable.

— Were sent from Lisbon Brushes of 4 graphite brushes of same size and shape as the carbon brushes used in previous exp.
After long and heavy runs they show a perfect contact surface, even at 100 amps. and more, no trace of sparking can be seen.

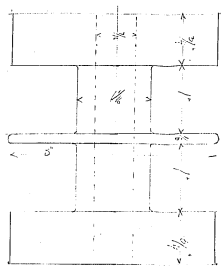
– Motor run without load.

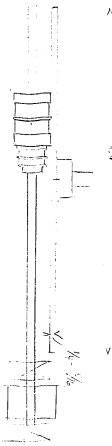
	Volts.	Amps.	Rev.	Watts.
1)	3.8	8.0	207	30.4
2)	6.2	8.1		
	6.3	8.0	610	50.4
3.	8.6	8.2	855	71.
	8.8	8.1		
	9.8	8.4		
4.	9.9	8.4	1123	83.
	10.0	8.3		
	10.1	8.2		
	10.2	8.2		
5.	10.4	8.3	1280	85.3
	10.4	8.2		
	10.5	8.2		

Motor loaded by Brake used in previous exp. Tachometer used.
To the weights given in following table has to be added the weight of spring balance, 10 oz.
Arm of brake 3 in, Pulley diam 6 7/8".

Voltage	Current	Speed	Weight	Watts Consumed	H.P. Delivered	Efficiency
1 41	94	700	10	3854	4.27	82.7 %
2 42	94	950	8	3948	3.64	68.6 %
3 43	84	—	—	3612		
4 43	100	850	12	4300	4.6	85.2 %
5 42	97	850	12	4074	4.3	85.2 %
6 41	105	—	8	4305	3.53	82.0
7 42	82	950	—	3444		
8 42	81	—	—	3402		
9 43	75	—	—	3225		
10 42	75	1000	7	3150	3.39	86 %

	Voltage	Current	Speed	Weight	Watts consumed	HP delivered	Efficiency
1	21 (motor before test)	22	1520	~	462		
2	24	27	1250	1	646	.86	?
3	42	73	1000	6	3060	2.94	.716%
4	41	85	900	8½	3480	3.65	.78 %
	New Brake						
5	30	20	1825	5 lb 14 oz	600	.585	72.5%
6	42	30	1830	13 lb	1260	1.3	77 %
	41	34			1394		
7	42	38	1520	17 lb 1 oz	1590	1.415	66.5 %
8	41	39	1450	19 - 1 oz.	1600	1.5	70%





Experiments on magnetic Speed Controller for Automobile

The rotating magnet is of machine steel and has about 240 turns of #14 wire.
The disc is also machine steel.
During the turning of the face of some the edges have spring back, so that the finished face is a concave surface of ca. 1/16" depth.
The back of disc is not finished this causing a variation in thickness of disc of about 3/32 maximum.
The rotating magnet slides on a 9/16" shaft and is prevented from turning relatively to same by a key sliding in a long seat.
The collar in middle of magnet is rounded on the edge and extends 10/1000" beyond the legs of the magnet, thus leaving an air space of 10/1000 between magnet and ~~pole~~ disc.
Resistance of winding: ca 1/4 ohm.

Experiment.
The magnet is excited and blocked and the force required for keeping the disc slowly rotating read by a spring balance. Collar of magnet is 8" from centre of disc and the Balance is attached to a binding screw on periphery of disc, 12 1/2" from centre.

	Current.	AW	Pull on 12¼"	"Bite"
1) 1 Cell	4 Amps	960 th	6.5 lbs	10 lbs
2) 2 Cells.	8 "	1920 "	10¼	13.5
3) 3 "	12.1"	2880	12.4	15.5

Letting the Magnet rotate at rate of 1500 per min, it will transmit 1) .435 HP 2) .59 HP 3) .675 HP

By using thinner wire (which when insulation is left out of consideration, gives same number of Amp turns) the energy used for the Excitation might be reduced to any degree — All other magnitudes, surface speed included, being constant, the pull of the magnet will be approximately proportional to the Diam. and the length of Magnet, and to the square of the saturation in airspace

The shaft is 9/16" in Diam. and further weakened by a good sized key seat. The least little unbalanceness — and still more so eccentricity of the axis of Gravity — makes the magnet vibrate violently during run. The tendency for wiggling of the plane of rotation causes vibrations in the disc of varying thickness, these being further exaggerated by the springy steel. The pull of the magnet does not suffice to keep same and

disc in permanent contact, and consequently will the disc ring — at high speed and when magnet is near the edge with an awful strong sound audible inside of the other buildings.

The means for improving this are evidently 1) to balance magnet perfectly — 2) use a thicker shaft and arrange bearings so as symmetrically as to allow balancing of shaft. 3) apply a heavier disc, perfectly of wrought iron.

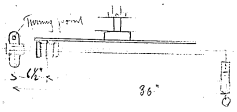
This experiment is for shown being a fair test of the practicability of the idea

After a very short run the vibrating magnet pressed the rounded collar deep into the disc giving distinct appearance of a "phonogram" and the other that of a "polygon".

Magnet bored to 5/8" diam., rewound with 340 turns of #16 wire and carefully balanced and turned off on shaft. As a sufficient large disc of wrought iron could not be obtained, a new one was cut out of 1/2" soft sheet steel and finished on both sides to 3/8" thickness.

This disc is perfectly plane, not concave.

The test at rest gives following results



1)	1 Cell	2.2 Amp.	530 AW	7 lb. Pull.	39 lbs Attrach.
2)	2 Cells	4.2	1430 "	10¼	57 "
3)	3 "	6.3	2140 "	12½	69 "

The "Bike" is found to:

		Pull on 12½"	Bike (at 10")	HP at 1500
1)	2.2 Amp.	7 lb	8.6 lb "	
2)	4.2	11 "	13.5 "	.59
3)	6.3	12 "	14.25 "	.62
4)	6.3 " stands to bike at 17:		21 "	.42

In this case the little collar is case-hardened. The coefficient of friction is 20%

The vibrating and ringing is very much reduced, still not all together prevented so that disc after short run shows same symptoms as the previous one, inducing the ringing steadily increase.

The most serious objection seems to be the rapid wearing off of the surface of contact. The collar may well be made to stand, but even at perfectly smooth run the disc, while ~~dirty~~ cutting, as the breadth of collar is limited and the pressure quite high as well as a sliding can not be prevented by change of

speed.

Even very short vibrations reduce the useful bike ~~to~~ such an extent that only test during run gave us results

---

More Experiments continued from pag 119.

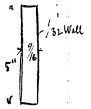
X 1/32" wall

Upper 1" of X bored out leaving

XI Upper 1½" bored out.

The object of this is to obtain a higher saturation in part of the core at the very start and thus do away with the dead part of the curve. Works pretty well, especially after wall of upper part is diminished to 20/1000"

XII



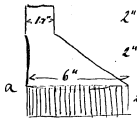
Current	Deflect.	Same		
0	123		0	112
250	135	with	240	120
585	155	Collar	580	149
1060	196		1040	219
2000	332		1540	313
2450	406		2120	437
3200	520		3080	664

XIII

Thin piece bent out of 7.5/1000" armature iron. Two inches from bottom the core is cut into 1/8" strips and these spread out like an umbrella.

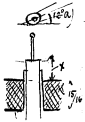
This core evidently has too little iron.

XIII



2" Development of core.
2" Core is rolled from b.
2" This core is very light and is readily attracted by the cast iron frame of meter wherever it is placed in lower end by a brass weight.

The core can be raised and lowered relatively to beam so as to adjust the free surface above solenoid at start.



x = 9/32, lowest position.

0	100	250	508	
500	133	270	668	Curve nearly straight
750	203	355	818	
1000	278	418	1085	
1550	400	485	1175	
1950	475			

Irregularity in curve due to magnetic properties of cast iron of meter which is initially too near.

(b) x = 9/16 annual Defect.

0	100	1500	400	
250	144	1900	588	
500	185	2500	732	
750	230	3000	907	
1000	306	3120	1150	
1500				

c) x = 7/8.

0	100	1500	345
250	132	2000	528
500	166	2500	885
730	240	3150	1130
1000	260		

d) x = 1 3/8 highest position.

0	100	1500	425
250	125	2000	670
500	155	2500	954
780	195	3000	1145
980	235		

May 2nd. 1900.

The thin sheet iron core had to be abandoned, as the strong pull, high induction and consequent straight curve were inseparable from high hysteresis and different deflections at ascending and descending runs.

The best results so far are obtained on a core 5 in long, 9/16 at drum and 1/32 wall, with an 1½" collar at the lower end.

Distance from ~~from~~ top of core to knifedge 1 7/16"
Distance from top of coil to knifedge at 15° deflection (downward) 1 7/8".
Length of Beam 2 1/2"; of intersecting arm 4 1/4". Coil has for each side of three wire system 2 layers à 14 turns and for the short 1000 turns of no 37 copper wire.

	Current I	Current II	Deflection	Corrected Current ~~Deflection~~
	.469 Amp	188.7/A	894	.469 Amp
5 minutes later	.468 "	178	890	.452 "
10 "	471	179	895	458
15 "	481	183	915	451
	444	183	860	444
	395	184	706	398
	347	184	662	350
5 "	296	186	585	308
15 "	297	186	589	307
10	291	187	580	284
15	292	180	580	282
	253	182	485	250
	207	182	387	198
	159	184	310	162
	120	184	250	123
5 "	121	185	248	128
10 "	1248	185	241	131
15 "	1205	186	240	130
20 "	.121	186	242	131
	79	187	196	92
	39	188	158	55
	0	189	127	20
	0	188	125	16
	0	189	122	20
	0	185	121	065.

Increasing Current.

	Current I	Current II	Deflection	Corrected Current
	.38	.0185	146	45
	.78	183	179	78
	.118	183	205	118
5 min	121	186	229	131
10 "	121	186	229	131
15 "	121	186	230	131
	161	185	288	167
	202	185	358	208
	253	185	454	259
	292	182	528	289
5	292	182	527	289
10	290	182	525	287
15	265	180	575	276
	337	179	612	324
	385	178	710	369
	434	178	805	418
	470	177	871	450
5 "	475	178	880	459
10 "	481	182	890	478
15 "	432	182	900	479.

As the starting current does not keep constant a correction has to be introduced.

3.45 Amps in heavy coil; 0 in fine coil; deflection 520
3.92 " " " " " " " " " 610
3.45 " " " " " " " " " 520
3.45 " " " " .0183 " " " " 635
.41 Amp. corresponds to 90° defl.
.0183 " " " " 115° "
Hence .0183 Amp in fine :: .6 Amp in heavy coil

	1.53 amp in heavy coil,	0 amp in fine;	defl: 205°
	1.53 – – –	.0182 – – –	202
.43	1.53 – – –	0 – – –	205
	2.01 – – –	– – – –	258

$$\frac{.43}{53} \times 87 \times \frac{183}{182} = .662.$$

The starting coil has a relatively strong action at lower currents. This probably being due to the large diameter and and consequent low density in an at two positions of core.

and higher pos

The correction of current will therefore be too small at lower positions and ought to have the equation.

$$I_c = I + \left(\frac{-183 + i}{183}\right) \cdot .6 + \frac{a}{I} \cdot \frac{(-183 + i)}{183}$$

where a is some small fraction

The preceding tables are corrected by means of the formula

$$I_c = I + \frac{i - 183}{183} \times 0.6.$$

The readings taken at intervals of 5 min were to determine whether the core by accidental pulsations of current and pendeling of beam tended to approach an average position between ascending and descending curve. In 3 cases out of 4 in the descending curve it really shows such tendency.

May 8th

The starting coil is fed from 3 Storage cells in order to keep the current const. The milliammeter shows during the whole run 180 – 181 mm.

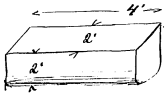
Amp	defl.	Current.	defl.
5.71	1055	526	998
540	1010	582	1055
524	973		
486	912		
452	850		
399	755		
352	660		
307	585		
264	485		
209	387		
164	310		
123	245		
87	188		
40	145		
0	110		
39	138		
80	175		
122	223		
162	284		
205	358		
254	454		
294	524		
344	620		
388	705		
434	805		
474	889		
505	945		

Very satisfactory curve in all directions.

Ayrie 1805.

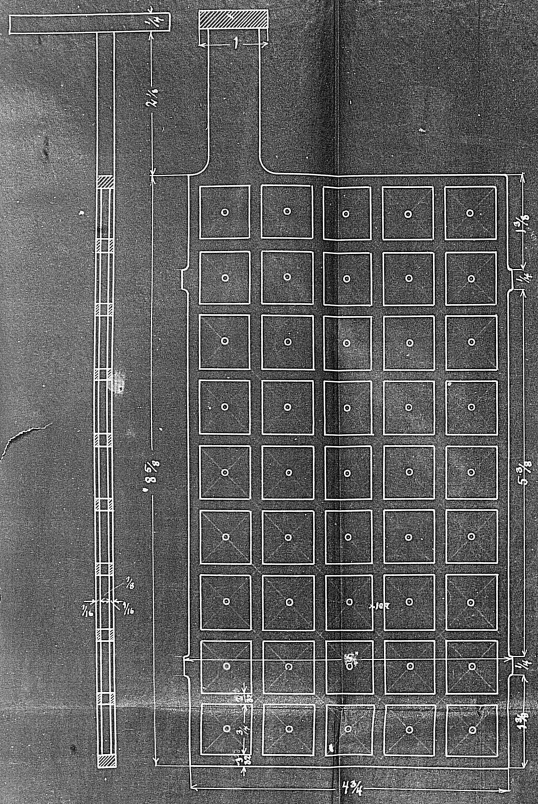
Tanks for precipitating active material for Battery. —

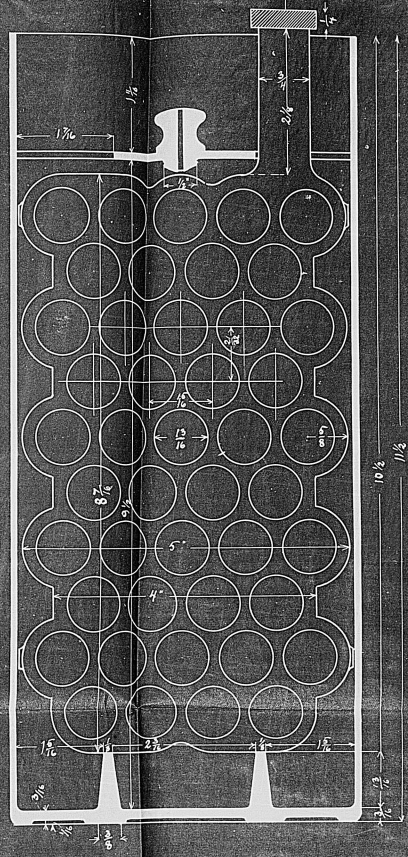
Size of Tanks: 2' x 2' x 4'

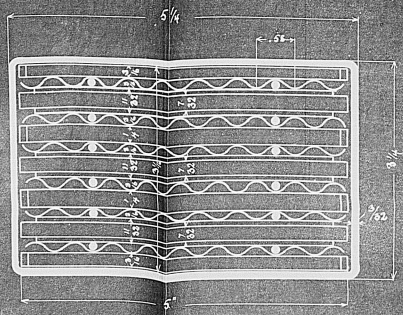


To determine the amount of water required for washing precipitates, tanks C and D were thoroughly cleaned and filled by 10 lbs of Iron sulphate each. This was dissolved by stirring, bottom KOH.

C was just neutralized - D was given a slight excess of Alkali. The precipitates were each time allowed to settle below house faucet, then occupying 3453 cub. in. The water drained off every time is 13824 cub. in.

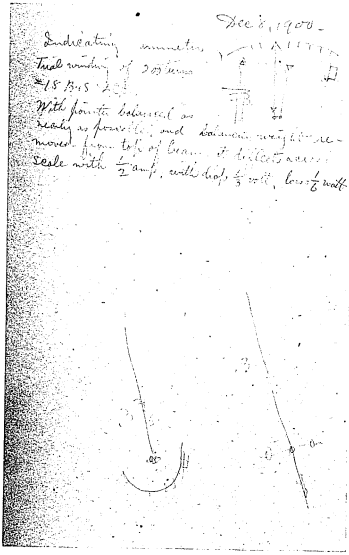






"Chloride Accumulator."

[ITEM FOUND IN BOOK]



Iodine Experiment

May 8th, 1901

Core 8" away from frame same as Curve #1

Curve #2

Same Conditions as for curve #1 but more care taken with reading especially with time with Bellinelli Commutator.

Iodine amps.	Secs.	# of Step	1845 mil Ampere Storage Battery constant in amount of iodine at 117.5 mil amps.
0.00	0=50 sec	0	
.0555	90.	1	
1.4475	149.	2	
1.449	200.	3	
1.975	290.	4	
2.375	360.	5	
2.750	430.	6	
3.235	520.	7	
3.085	589.	8	
3.930	655	9	
4.600	785	10	
4.995	853.	11	
5.56	925	12	Other iodine readings begin here.
6.00	992	13	
6.37	1062	14	
6.87	1130	15	
7.37	1212	16	

.5
.05
.055
1.0455
1.445

.05
.1
.005

.05
.05
.25
.025

.05
.05
.5
.045

.0475

.98
.05
.0490

1.475
.05
1.925
.05
2.5
.25
2.75

8.9
.05
.445

8.98
.05
.4490

9.5
.05
.475

2.5
.25
2.375

3.235

.5
.05
.025

.05
.05
.025

.05
.05
.025
.05
.05
.025

8.6
.05
.430
3
3.93

9.5
.05
.475
5
4.875

.98
.05
.0490

4.549

Time reading not corrected yet.

5.56
6.00
6.37
6.87
7.37